Kaon LT Status Update

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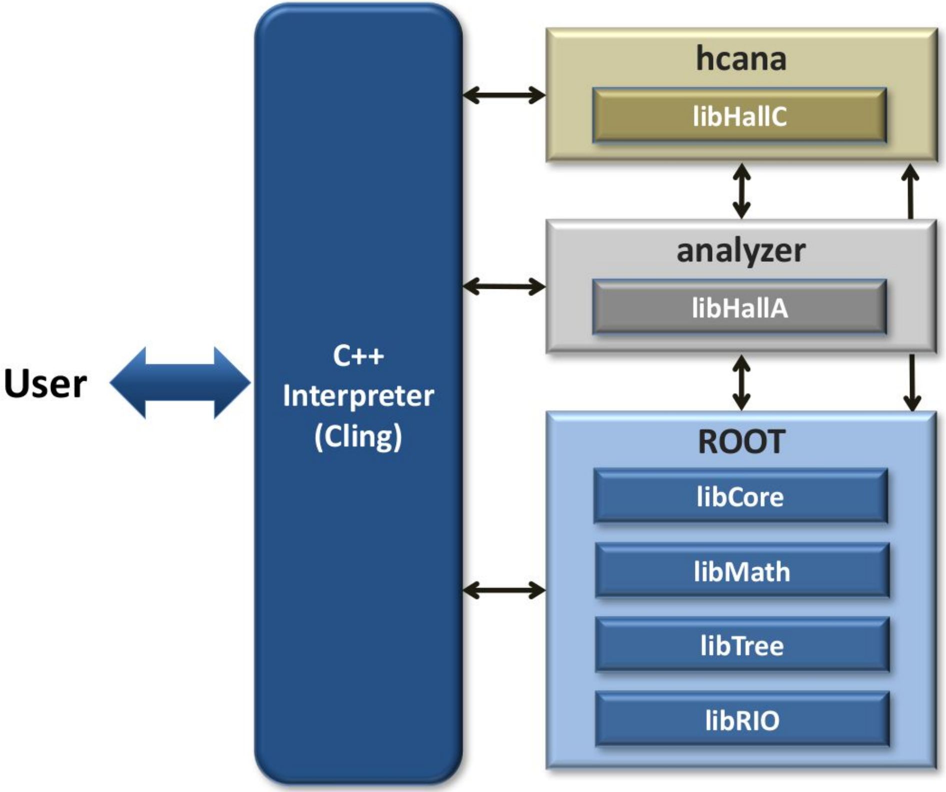
Richard Trotta

Analysis Framework

- The hcana documentation can be found at...
  - https://hallcweb.jlab.org/hcana/docs/modules.html
  - https://redmine.jlab.org/projects/podd/wiki/Documentation
- libHallA can be found in hcana/podd
- libHallc can be found in hcana/src



Hcana Structure

- Raw EVIO data loops through Decoder method (which converts signals to code)
    - Each detector is decoded individually
- THaSpectrometer::Reconstruct() is called to begin coarse processing
    - This loops raw hit data through tracking detectors and calls THcDC::CoarseTrack to find all tracks with focal plane quantities
    - Raw hit data loops through remaining apparatus and calling CoarseProcess() method
- Coarse hit data is looped through tracking detectors for fine processing
- THcHallCSpectrometer::FindVertices() is called to reconstruct target quantities and fill track momentum
    - Coarse hit data looped through nontracking detectors calling FineProcess()
    - Calls THcHallCSpectrometer::TrackCalc() to fill golden tracks
    - Calls CalcPID which combines PID info using THcPIDinfo

Replay Structure

Four main configuration directories (DBASE, PARAM, MAPS, DEF-files)

- DBASE
  - *.param, tells replay which parameters to be called in PARAM
  - *.kinematics, physics kinematics (e.g. beam energy, angles)
  - *.database, sets global variable names for *.param and *.kinematics in DBASE and *.map in MAPS so replay knows which to use
- PARAM
  - Parameters for detectors, triggers, etc.
- MAPS
  - Mapping of crates, channel #s, etc.
  - Map between detector modules and replay variables
  - [xAERO=THcAerogel, xCAL=THcShower, xDC=THcDC, xCER=THcCherenkov, xSCIN=THcHodoscope, xRASTER=THcRaster]
    - x={h,p}

Replay Structure

- DEF-files
  - THaOutput, ROOT output writer
  - Interfaces with THcAnalyzer to output user defined ROOT trees and histograms

*.def

  - Variables created in detector classes in DefineVariables() method (e.g. P.hodo.goodAdcPulseAmp)
  - Block variables write multiple variables to tree (e.g. block P.gtr.*)
  - Histograms can be defined for specific variables with and without cuts
    - e.g. TH1F h1 ‘Title;x-title;y-title’ var nBins xLow xHigh cut1&&cut2||cut3

*_cuts.def

  - DEF-files defining cuts create global cut objects for histograms and interactive analysis
    - e.g. time_cut1 P.dc.1u1.time>0&&P.dc.1u1.time<250
  - Define cuts with different stages of analysis
    - e.g. RawDecode, Decode, CoarseTracking, CoarseReconstruction

Tracking in hcana

- As we discussed earlier there the raw hit data is coarse processed which loops over PMT data set in PARAM
    - This is pedestal subtracted from ADC value and the number of photoelectrons is calculated
- This coarsed hit data is then fine processed which will give us the higher level physics data
    - This requires one to find the golden track
- THcHallCSpectrometer::FindVertice()
    - Transports all the tracks in focal plane transport coordinates to the target using CalculateTargetQuantities() method. The tracks are then rotated to the LAB frame
- THcHallCSpectrometer::TrackCalc() will find golden track by one of three methods (flags of each method are in PARAM/(S)HMS/DC/hdc_cuts.param)

Methods of golden tracks

1. χ^2 fit, simply the smallest χ^2 is chosen
2. SCIN method
    - Select best track through HMS by seeing which track is closest to S2Y or if none then S2X
    - If there are still multiple tracks select track with smallest χ^2
3. Prune method
    - First loop over the following...
        - xp, yp, ytar, delta, shower energy, ToF, β, # of DoF of track, χ^2, # of PMT hits on track (within time cut), χ^2 of β, focal plane time relative to nominal time, a hit in S2Y and S2X
    - Reject all tracks which have a greater value than these quantities
    - If there are still multiple tracks select track with smallest χ^2

Single tracking efficiency

- Once we have the golden tracks we must find our tracking efficiencies

$$SingFidTrackEff = \frac{hdid}{hscinshould} \pm \sqrt{\frac{hscinshould - hdid}{hscinshould - 0.0001}}$$

- At the end of each event, ‘hscinshould’ is incremented if…
  - It hit only in desired range of x & y
  - If the slope of track along x & y isn’t too high
  - If 4/4 in hodoscope
  - At least 2 PE in Cherenkov
  - Ratio of energy deposit in calorimeter to central momentum is greater than 0.7
- ‘hdid’ is the same as ‘hscinshould’ only if there is at least one track

Yield Calculations (old slide)

- Current is calculated per event with a threshold current of 2.5 uA for BCM4B [See Sangwa's Talk]
- I have not incorporated non-scaler EDTM based calculations so no electronic livetime included
- Yield is calculated by

Let's look into how these four values are calculated

$$Y = \frac{N \times PS}{Q \times \varepsilon \times (cpuLT)} \pm \frac{\sqrt{N}}{N} Y$$

  - N is number of reconstructed events passing cuts, PS is the prescale value, and ε are tracking efficiencies

Number of Events (old slide)

- Two types of event selection
  - Using the event type leaf fEvtHdr.fEvtTyp where EvtType = 1 or 3 is a SHMS event and EvtType= 2 or 3 is a HMS event (previously used method)
  - Applying proper cuts to the TDC leaves to get the SHMS (3of4 in T.coin.pTRIG1_ROC2.tdcTime) and HMS (elreal in T.coin.pTRIG3_ROC1.tdcTime) event selection (more on this later)
  - In the end, these should result in the same event selection as long as fEvtHdr.fEvtTyp leaf is properly selecting events
- A number of cuts were applied as well
  - SHMS cuts: P_cal_etotnorm > 0.05, P_hgcer_npeSum > 1.5, P_aero_npeSum > 1.5
  - HMS cuts: H_cal_etotnorm > 0.6, H_cal_etotnorm < 2.0, H_cer_npeSum > 2.0

CPU Livetime (old slide)

- Originally this was calculated through purely scalers
  - cpuLT = L1Acc/[(ptrig1/ps1)+(ptrig3/ps3)]
- To improve this beyond the level one accepts the TDC leaves (described above) were used
  - The same cuts as the event selection were applied
  - cpuLT = (TDC_trig1cut+TDC_trig3cut)/[(ptrig1-EDTM/ps1)+(ptrig3-EDTM/ps3)]
- The latest improvement was to separate the HMS cpuLT and SHMS cpuLT and calculate them separately
  - cpuLT_HMS = TDC_trig3cut/[(ptrig3-EDTM)/ps3]
  - cpuLT_SHMS = TDC_trig1cut/[(ptrig1-EDTM)/ps1]

Tracking Efficiencies (old slide)

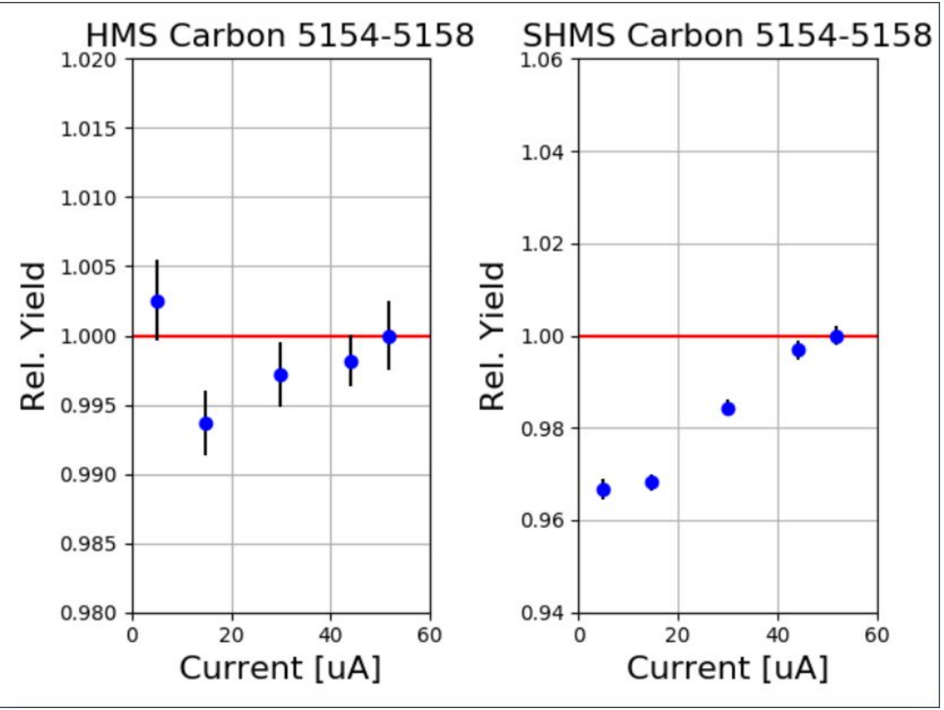
- The runs that I looked at had electrons in the HMS and pions in the SHMS
    - P_{HMS}=-3.266, Θ_{HMS}=12.50, P_{SHMS}=+6.842,Θ_{SHMS}=6.55
    - P_{HMS}=-4.204, Θ_{HMS}=14.51 P_{SHMS}=+6.053,Θ_{SHMS}=6.55
- HMS tracking was found by applying cuts to H.dc.ntrack
- SHMS tracking was found by applying cuts to P.dc.ntrack
- The HMS used the electron tracking efficiency while the SHMS used the pion tracking efficiency (note that originally the SHMS used the hadron tracking efficiency but there was little change going to pion tracking)

Tracking Efficiencies (con't) (old slide)

- Electron tracking efficiency cuts -> H_hod_goodscinhit == 1 & H_hod_betanotrack > 0.8 & H_hod_betanotrack < 1.3 & (H_dc_1x1_nhit + H_dc_1u2_nhit + H_dc_1u1_nhit + H_dc_1v1_nhit + H_dc_1x2_nhit + H_dc_1v2_nhit) < 20 & (H_dc_2x1_nhit + H_dc_2u2_nhit + H_dc_2u1_nhit + H_dc_2v1_nhit + H_dc_2x2_nhit + H_dc_2v2_nhit) < 20 & H_cer_npeSum > 0.5 & H_cal_etotnorm > 0.6 & H_cal_etotnorm < 2.0
- Pion tracking efficiency cuts ->P_hod_goodscinhit == 1 & P_hod_betanotrack > 0.5 & P_hod_betanotrack < 1.4 & (P_dc_1x1_nhit + P_dc_1u2_nhit + P_dc_1u1_nhit + P_dc_1v1_nhit + P_dc_1x2_nhit + P_dc_1v2_nhit) < 20 &(P_dc_2x1_nhit + P_dc_2u2_nhit + P_dc_2u1_nhit + P_dc_2v1_nhit + P_dc_2x2_nhit + P_dc_2v2_nhit) < 20 & P_cal_etotnorm > 0.05 & P_cal_etotnorm <= 0.6 & P_hgcer_npeSum > 10 & P_aero_npeSum > 3
- Hadron tracking efficiency cuts ->P_hod_goodscinhit == 1 & P_hod_betanotrack > 0.5 & P_hod_betanotrack < 1.4 & (P_dc_1x1_nhit + P_dc_1u2_nhit + P_dc_1u1_nhit + P_dc_1v1_nhit + P_dc_1x2_nhit + P_dc_1v2_nhit) < 20 &(P_dc_2x1_nhit + P_dc_2u2_nhit + P_dc_2u1_nhit + P_dc_2v1_nhit + P_dc_2x2_nhit + P_dc_2v2_nhit) < 20 & P_cal_etotnorm > 0.05 & P_cal_etotnorm <= 0.6

Carbon plots (old slide)

P_{HMS}=-3.266, Θ_{HMS}=12.50 P_{SHMS}=+6.842,Θ_{SHMS}=6.55



P_{HMS}=-4.204, Θ_{HMS}=14.51 P_{SHMS}=+6.053,Θ_{SHMS}=6.55